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# THE CONSUMPTION OF RED PUPUNHA (BACTRIS GASIPAES KUNTH) INCREASES HDL CHOLESTEROL AND REDUCES WEIGHT GAIN OF LACTATING AND POST-LACTATING WISTAR RATS

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## Abstract

**Introduction—**The lactating and post-lactating periods are marked by large metabolic change. Production of milk is 60% lipid dependent. We reported in a recent scientific meeting that Red pupunha palm tree fruit increases HDL cholesterol in lactating rats. This study evaluated if consumption of Red Pupunha by adult female rats has a beneficial impact on the lipid metabolism of lacting and post-lacting adult rats.

**Objective—**Evaluate if consumption of red pupunha has a beneficial effect in the lipid metabolism of lacting and post-lacting adult Wistar rats.

**Research Methods—**Four groups including two for control; (1) control adult lactating rats, (2) control adults post-lactating rats; and two experimental groups; (3) pupunha adults lactating rats and (4) pupunha adult post-lactating rats were evaluated and compared regarding: weight gain, food consumption, plasma total protein, glucose, total lipid, triglycerides, total cholesterol and HDL-cholesterol levels. The mean difference and its 95% confidence intervals were used for group comparisons. Group comparisons were evaluated by using analysis of variance (one-way ANOVA). The statistical significance of the pairwise differences among groups was assessed by using the two-sided Tukey test.

**Results—**There were no important differences in food consumption, plasma glucose, total lipids and triglycerides among groups. The red pupunha lactating group gain less weight showing lower body mass index (BMI) than controls ($p < 0.05$). Total cholesterol was lower in red pupunha lactating than in controls but not in the red pupunha post-lactating group as compared to controls.



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Triglycerides were lower in the post-lactating red pupunha group as compared to the control group ($p = 0.039$) but not for the lactating groups. Red pupunha lactating and post-lactating groups had higher HDL-cholesterol than their corresponding control groups ($p \leq 0.01$).

**Conclusion—**Original findings include the beneficial effect of red pupunha in post-lactating rats increasing the HDL-cholesterol and lowering the BMI. Red pupunha was confirmed to increase HDL-cholesterol in lactating rats. These results suggest that red pupunha is a healthy fruit to be consumed during lactating and post-lactating periods as it is related to better lipid profile and less body weight gain.

### Keywords

Red pupunha fruit; lipid profile; HDL-cholesterol; nutrition; lactating and post-lactating periods

## Introduction

The lactating and post-lactating periods are marked by large metabolic change. During lactation, the substrates glucose, amino acids, free fatty acids, triglycerides and hormones are transported in larger quantities to mammary glands (1, 2). Meanwhile, during the post-lactating period those substrates used for milk production are directed to other tissues and adipose tissue to replace what was consumed (3). During the post-lactating period, there is also an increase activity of lipoprotein lipase enzyme, increasing the reception of the triglycerides that come from the diet.

Compared to carbohydrates, the lipids are greatly present in the daily nutrition of large part of the Western population (4, 5). Lipids are all the fatty substances, chemically produced from fatty acids, the most common examples are oils from animals and plants. As reported by Willett (20) it is important to consume high amounts of fat, although known as “good fat”, avoiding saturated fats and choosing the essential fatty acids (omega-3 and 6). These substrates provide a healthy shielding effect for the circulatory system, reducing the serum low density lipoprotein LDL-cholesterol (6). According to Marcil et al. (7) the short chain fatty acids promote the lipids absorption and the liver metabolism, resulting consequently in blood cholesterol utilization. Moreover, it is known that the fatty acids have an important participation in energy production, cellular metabolism, muscular activity, syntheses production of hemoglobin, cellular division, nervous impulse transmission, and very importantly on the development of the brain and the retina in newborn children (8-11).

In the Amazon region of Brazil, some palm trees produce fruits that are highly appreciated as food. These fruits have high nutritional value and are rich in lipids. These lipids stimulate the absorption of pro-vitamins resulting in a better bio-availability of these components. It is important to highlight that the red pupunha (Bactris gasipaes Kunth) is one of most appreciated fruits in Brazil. This fruit can be consumed raw or cooked; can be eaten by itself or as a complement with other food items. Moreover, from the stem of this palm tree, the heart (Palmito) is also edible and highly appreciated locally and internationally. As the fruits of other palms, the red pupunha is very oily and rich in essential fatty acids, carotenoids (essential precursors of Vitamin A) and tocopherol (Vitamin E family).

According to Arkcoll and Aguiar (21) the lipid composition of red pupunha include monounsaturated fatty acids that are 36.6 to 47.8% oleic acid, saturated fatty acids that are 30.5 to 40.3% palmitic acid and 2.4 to 7.0% steric acid, and have a low percentage of polyunsaturated acids (11.2 to 21.1% linoleic acid, 5.7 to 7.1% palmitoleic acid and 1.5 to 5.5% linolenic acid). Moreover, we reported (23) in the Annual Scientific Meeting of the mason Region Federal University in 2001 that red pupunha increases the HDL-cholesterol plasma in lactating rats. This type of lipid is known as the “good cholesterol”, because transfers the low density cholesterol of human body tissue to liver, lessening the amount of cholesterol in the blood; thus, reducing the risks of diseases caused by hypercholesterolemia (15). Therefore, the consumption of this fruit can be advantageous during lactation, because, according to Oller do Nascimento and Williamson (3) during this period, the production of milk is 60% lipid dependent.

Given that there is controversial evidence about the human consumption of oily fruits in the metabolism of lipids in the organism, and the lack of information about the benefits of eating this fruit; the present study is seeking to demonstrate the potential nutritional benefits of red pupunha. Thus, the main objective of this study was to evaluate if the consumption of red pupunha alters the lipid profile and body mass index of lactating and post-lactating rats.

## Subjects and Methods

For this study we obtained Wistar female adult rats from the same batch from the biotery of the Federal University of Amazon Region (UFAM). The biometric and biochemical analysis was performed in the UFAM’s Physiology Laboratory. The rats were kept at constant temperature of 24 °C ± 1 °C, light cycle controlled (12 hours clear dark room/12 hours dark room), with water and food given ad libitum during the period of the experiment.

The adult animals were divided in the following groups: control lactating rats (N = 10); control post-lactating rats (N = 8); pupunha lactating rats (N = 7) and; pupunha post-lactating rats (N = 8). The control groups were feed only with commercial rat food (LABINA®), while the pupunha groups were fed with a mixture of commercial rat food and red pupunha. The diets began on the first day of lactation and post- lactation, respectively.

For the preparation of the commercial rat food with red pupunha, the commercial rat food was grinded first, and then dry pulverized red pupunha and casein were added. Water was used for homogenization and give consistency to the mix. The mix was made small pellets that dried in an oven at 60° Celsius.

The food consumption was evaluated daily, subtracting the weight of the food leftover from the weight of the food originally offered. With these data it was possible to assess the average food consumption of each group. In addition, the rats were weighed every day to determine the weight gain in each rat and group during the experiment by using a semi-analytical scale QUIMIS BG 4000.

Thirty days after we started the experiment, the animals were sedated by inhalation of ethyl ether. Blood samples (5ml) were collected directly from the heart of each rat. The collected blood was immediately centrifuged (2,500 rpm for 10 minutes) and plasma was separated.

The samples were stored at − 20° Celsius for later analysis. Biochemical determination of the samples included total protein (g/dL), glucose (mg/dL), total lipids (mg/dL), triglycerides (mg/dL), total cholesterol (mg/dL), and HDL-cholesterol (mg/dL) .

Total protein content, glucose, total lipid, triglycerides, total cholesterol in the plasma was determined using a commercial kit (Doles Reagents Ltda., Goiânia, GO, Brazil), using the biuret reagent in total protein and sulfuric acid in total lipid. The HDL-cholesterol content was determined using a commercial kit (In Vitro Diagnóstica S/A, Itabira, MG, Brazil), following kit directions (In Vitro Diagnóstica S/A, Itabira, MG, Brazil). The absorbency was determined with a guide spectrophotometer SPECTRONIC ® 20 GENESYSTM.

Group comparisons regarding means and mean differences on weight gain, food consumption and biochemical parameters were evaluated by using analysis of variance (one-way ANOVA). The statistical significance of the pairwise differences among groups was assessed by using the two-sided Tukey test.

## Results

### Weight gain and food consumption

Weight gain and body mass index of the lactating pupunha group were less ($p < 0.05$) than those from their corresponding control group (Table 1). The food consumption was statistically significant different among the lactating group during the entire experiment (Table 1). No signicant statistically associations were found among weight gain and food consumption among the post lactating group (Table 2).

### Evaluation of the biochemical plasma

Glucose, total lipids and total cholesterol did not showed important or statistically significant differences between the groups, except a lower total cholesterol in the lactating pupunha group as compared to the control group ($p = 0.051$). Triglycerides were lower in post-lactating red pupunha group as compared to the control group ($p = 0.039$) but not for the lactating groups. Red pupunha lactating and post-lactating groups had higher HDL-cholesterol (table 1 and 2) than the control groups ($p \leq 0.01$).

## Discussion

Agronomic studies show that there is an expansion in the cultivation of palm Bactris gasipaes for extraction of palm heart, because of the good agronomic, industrial and commercial features compared with other palm tree with edible fruits (16, 17). In this study we demonstrated that besides the palm heart (Palmito), the consumption of the fruit of the palm B. gasipaes, red pupunha, is highly beneficial to human health, especially during lactation and post-lactation periods.

Studies demonstrated that linoleic acid reduces body fat in animals and humans (18, 19). Therefore, the lipid content of pupunha red containing around 11.2 to 21.1% linoleic acid (21), allows us to understand why the lactating and post-lactating groups that fed pupunha plus commercial rat food were lighter than controls, despite showing an upward trend in food consumption. Our results disagree with those from Leite et al. (24) that found that the red pupunha feed rats were heavier than controls not feed with it while the food consumption did not differed between groups.

We observed an increase in plasma lipids and triglycerides in both post-lacting groups as compared to the lactating ones. A reduction of plasma lipids occurs in lactating rats as it is used by the mammary gland during lactation. The literature shows that in post-lacting rats, changes occur in adipose tissue metabolism in order to replenish what was depleted during lactation (3).

According to Ferreira and Pena (25) the red pupunha is rich in fiber. These authors demonstrate that in 100g of fruit “in nature” there are 1.6 grams of fiber, when cooked; fiber is reduced to 1.4 grams, and when is dried and pulverized is further reduced to 1.1grams.

The non-significant reduction in total cholesterol of the groups that ate commercial food plus pupunha (Table 1) agree with other studies showing that high-fiber foods reduce cholesterol in plasma (26,27). Furthermore, the reduction in total cholesterol and non-significant reduction of triglycerides in the groups that ate commercial food mixed with red pupunha may be attributed to the significant increase in HDL-cholesterol in these groups. As Marcil et al. (7) reported, short-chain and high density lipoproteins, such as HDL-cholesterol, carry cholesterol and triglycerides inside the body’s tissues to the liver to be excreted or used in other metabolic processes. In this study plasma concentrations of LDL-cholesterol in the groups feed with red pupunha were much lower than 2.59 mmol/L, that is the optimal level considered by the American Heart Association according to Birtcher and Ballantyne (28). LDL-cholesterol are low density lipoproteins capable of transporting cholesterol from the liver to the cells of several other tissues thus increasing the cholesterol levels in blood. LDL-cholesterol is often called “bad cholesterol” because of its relationship with heart disease (29, 30).

We concluded from these results that the dietary intake of red pupunha is healthy, especially during the lactating and post-lactating periods; because, it increases plasma concentrations of HDL-cholesterol in rats. Moreover, this fruit is rich in fiber, reduced animal weight, plasma concentrations of total cholesterol and triglycerides. The results of LDL-cholesterol were inconclusive, thus reinforcing the need for conducting further studies on the benefits that consumption of red pupunha may promote in humans. In addition to the red pupunha, other fruits rich in lipids and fiber from Amazonian palm trees, often consumed by the local population, need to be evaluated to find out its benefits to human health.

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## Table 1

Comparison between lactating red pupunha and lactating control groups

| Characteristic | Red Pupunha Lactating Rats Mean (SD) (n = 10) | Control Lactating Rats Mean (SD) (n = 7) | Mean Difference (95% CI) | p-value |
|---|---|---|---|---|
| Food Consumption | 13.1 (0.95) | 12.1 (0.79) | 1.0 (0.06, 1.93) | 0.038 |
| Weight Gain | 224.0 (5.40) | 247.7 (9.54) | − 23.7 (16.0, 31.4) | <0.001 |
| Total proteins (g/L) | 38.0 (3.16) | 40.0 (0.00) | − 2.0 (−0.26, 4.26) | 0.076 |
| Glucose (mmol/L) | 5.87 (1.61) | 7.47 (1.73) | − 1.6 (−0.14, 3.34) | 0.069 |
| Total lipids (g/L) | 3.22 (1.58) | 3.10 (0.80) | 0.12 (− 1.27, 1.51) | 0.857 |
| TG (mmol/L) | 0.55 (0.16) | 0.60 (0.16) | − 0.05 (− 0.12, 0.22) | 0.536 |
| Total ch. (mmol/L) | 1.80 (0.41) | 2.81 (0.17) | −1.01 (0.70, 1.33) | <0.001 |
| HDL ch. (mmol/L) | 2.14 (0.47) | 1.24 (0.21) | 0.9 (0.49, 1.31) | 0.003 |

## Table 2

Comparison between post-lactating red pupunha and post-lactating control groups

| Characteristic | Red Pupunha Post-Lactating Rats Mean (S) (n = 8) | Control Post-Lactating Rats Mean (S) (n = 8) | Mean Difference (95% CI) | p-value |
|---|---|---|---|---|
| Food Consumption | 13.0 (1.41) | 12.1 (1.41) | 0.9 (− 0.61, 2.41) | 0.223 |
| Weight Gain | 231.3 (9.0) | 238.4 (8.5) | − 7.1 (−2.29, 16.49) | 0.127 |
| Total proteins (g/L) | 51.00 (11.3) | 46.00 (2.82) | 5.0 (− 4.674, 14.74) | 0.264 |
| Glucose (mmol/L) | 6.37 (0.56) | 6.52 (1.16) | − 0.15 (− 0.83, 1.13) | 0.747 |
| Total lipids (g/L) | 4.05 (2.14) | 4.04(2.54) | 0.01 (−2.51, 2.53) | 0.993 |
| TG (mmol/L) | 1.29 (28.2) | 1.52 (0.50) | − 0.23 (−0.21, 0.67) | 0.276 |
| Total ch. (mmol/L) | 2.18 (0.62) | 2.41 (0.39) | − 0.23 (− 0.33, 0.79) | 0.390 |
| HDL ch. (mmol/L) | 2.25 (0.48) | 1.58 (0.37) | 0.67 (0.21, 1.13) | 0.007 |